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DIODE

STEP STRESS TESTING PROGRAM

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FINAL REPORT
FOR
JANTX1N5623

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Prepared
For

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FOREWORD

This report is a summary of the work performed on NASA Contract NAS8-31944. The investigation was conducted for the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama. The Contracting Officer's Technical Representative was Mr. F. Villella.

The short-term objective of this preliminary study of transisters, diodes, and FETS is to evaluate the reliability of these discrete devices, from different manufacturers, when subjected to power and temperature step stress tests.

The long-term objective is to gain more knowledge of accelerated stress testing for use in future testing of discrete devices, as well as to determine which type of stress should be applied to a particular device or design.

This report is divided as follows: description of tests, figures, tables, and appendix.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

1.0 INTRODUCTION

DCA Reliability Laboratory, under Contract NAS8-31944 for NASA/Marshall Space Flight Center, has compiled data for the purpose of evaluating the effect of power/temperature step stress when applied to a variety of semiconductor devices. This report covers the switching diode JANTX1N5623 manufactured by SEMTECH and MICRO SEMICONDUCTOR.

A total of 48 samples from Semtech and 44 samples from Micro Semiconductor were submitted to the process outlined in Table 1. In addition, two control sample units were maintained for verification of the electrical parametric testing.

2.0 TEST REQUIREMENTS

2.1 Electrical

All test samples were subjected to the electrical tests outlined in Table 2 after completing the prior power/temperature step stress point. These tests were performed using the Fairchild Model 600 High-Speed Computer-Controlled Tester. Additional bench testing was also required on the devices.

2.2 Stress Circuit

The test circuit shown in Figure 1 was used to power all the test devices during the power/temperature stress conditions. The voltage was set by V_F and the current was varied in order to comply with the specified power rating for the device. At least one of the devices was subjected to maximum rated power (MRP). All remaining devices were

subjected to no less than 90% of MRP. See Figure 1 for load resistance values and voltages.

2.3 Group I - Power Stress

Thirty-two units, 16 from each manufacturer, were submitted to the Power Stress Process. The diodes were stressed in 500-hour steps at 50, 100, 125, 150 and 175 percent of maximum rated power (MRP) for 2500 hours or until 50% or more of the devices in a sample lot failed.* Electrical measurements were performed on all specified electrical parameters after each power step. See Table 1. (*See Notes at end of text.)

2.4 Group II - Temperature Stress I

Twenty-nine units, 15 from Semtech and 14 from Micro Semiconductor, were submitted to the Temperature Stress I Process. Group II was subjected to 1600 hours of stress at maximum rated power in increments of 160 hours. The temperature was increased in steps of 25°C, commencing at 75°C and terminating at 300°C or until 50% or more of the devices failed.* Electrical measurements were performed on all specified electrical parameters after each temperature step. See Table 1.

2.5 Group III - Temperature Stress II

Thirty-one units, 17 from Semtech and 14 from Micro Semiconductor, were submitted to the Temperature Stress II Process. Group III was subjected to 112 hours of stress at maximum rated power in increments of 16 hours. The temperature was increased in steps of 25°C, commencing at 150°C and terminating at 300°C or until 50% or

more of the devices in a sample lot failed.* Electrical measurements were performed on all specified electrical parameters after each temperature step. See Table 1.

3.0 DISCUSSION OF TEST RESULTS

3.1 Group I - Power Stress

3.1.1 Semtech. The Semtech sample lot completed the entire 2500-hour Group I testing with one catastrophic failure. The failure occurred 50 hours into the 175% MRP step. Serial number 7818 failed the maximum I_R limit. Typical characteristics of this sample lot's performance were:

1) The mean value for IR changed 137.66nA from an initial mean of 58.24nA to a final mean of 195.90nA.
2) The mean value for V_F changed 0.003V from an initial mean of 1.218V to a final mean of 1.221V.

The control units for this sample lot remained constant throughout the entire Group I Testing.

3.1.2 Micro Semiconductor. The Micro Semiconductor sample lot completed a total of 1000 hours of Group I Testing before the lot was stopped because 50% of the devices failed. The first failure occurred 150 hours into the 100% MRP step. Serial number 7856 failed the maximum I_R limit. The next two failures occurred 250 hours into the 100% MRP step. Serial number 7853 failed the maximum I_R limit. Serial number 7872 was removed from the Group I Testing as a visual catastrophic failure.

(See Table 8 for explanation.) The last five failures occurred 500 hours into the 100% MRP step. Serial numbers 7846, 7873, 7874, 7875, and 7877 were removed from the Group I Testing as visual catastrophic failures. (See Table 8 for explanation.) Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 24.0nA from an initial mean of 346.6nA to a final mean of 322.6nA.
2) The mean value for V_F changed 0.007V from an initial mean of 1.506V to a final mean of 1.513V.

The control units for this sample lot remained constant throughout the entire Group I Testing.

3.1.3 Statistical Summary - Group I. Table 4 outlines the results of Group I - Power Stress Process for each of the electrical parameters and all measurement points for both Semtech and Micro Semiconductor.

3.2 Group II - Temperature Stress I

3.2.1 Semtech. The Semtech sample lot completed 1440 hours of Group II Testing before the lot was stopped. The only catastrophic failure occurred 160 hours into the 275°C-temperature step. Serial number 7818 failed the maximum I_R limit. Serial numbers 7805, 7806, 7826, 7830, 7828, and 7832 were removed from the Group II Testing as MIL-S-19500 parametric failures. Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 154.04μA from an initial mean of 59.94nA to a final mean of 154.10μA.

2) The mean value for V_F did not change from an initial mean of 1.220V to a final mean of 1.220V.

The control units for this sample lot remained constant throughout the entire Group II Testing.

3.2.2 Micro Semiconductor. The Micro Semiconductor sample lot completed 480 hours of Group II Testing before the lot was stopped because 50% of the devices failed. The first six failures occurred 160 hours into the 105°C-temperature step. Serial numbers 7859, 7860, 7886, and 7861 failed the maximum I_R limit. Serial numbers 7881 and 7884 were removed from the Group II Testing as visual catastrophic failures. (See Table 8 for explanation.) The last two failures occurred 160 hours into the 125°C-temperature test Serial number 7862 was removed from the Group II Testing as a visual catastrophic failure. (See Table 8 for explanation.) Serial number 7883 was removed from the Group II Testing as a visual catastrophic failure. (See Table 8 for explanation.) Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 1664.5μA from an initial mean of 544.0nA to a final mean of 1665.0μA.

2) The mean value for V_F changed 1.434V from an initial mean of 1.484V to a final mean of 2.918V.

The control units for this sample lot remained

constant throughout the entire Group II Testing.

3.2.3 Statistical Summary - Group II. Table 5 of this report outlines the results of Group II - Temperature Stress I Testing, for each of the electrical parameters and all of the measurement points pertaining to both Semtech and Micro Semiconductor.

3.3 Group III - Temperature Stress II

3.3.1 Semtech. The Semtech sample lot completed the entire 112-hour Group III Testing with no catastrophic failures. Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 20.58nA from an initial mean of 80.32nA to a final mean of 100.9nA.

2) The mean value for V_F changed 0.009V from an initial mean of 1.363V to a final mean of 1.354V.

The control units for this sample lot remained constant throughout the entire Group III Testing.

3.3.2 Micro Semiconductor. The Micro Semiconductor sample lot completed a total of 96 hours of Group III Testing before the lot was stopped because 50% of the devices failed. The first two failures occurred 16 hours into the 250°C-temperature step. Serial numbers 7627 and 7629 were removed from the Group III Testing as visual catastrophic failures.* Serial number 7668 failed the maximum I_R limit. Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 73.92μA from an initial mean of 2.14μA to a final mean of 76.06μA.

2) The mean value for V_F changed 0.009V from an initial mean of 1.363V to a final mean of 1.354V.

The control units for this sample lot remained constant throughout the entire Group III Testing.

3.3.3 Statistical Summary - Group III. Table 6 outlines the results of Group III - Temperature Stress II Testing, for each of the electrical parameters and all of the measurement points for both Semtech and Micro Semiconductor.

4.0 FINAL DATA SUMMARY

Table 7 statistically summarizes the change in the mean value from the zero-hour data to the final data. The graphs of Figures 2 and 4 plot the cumulative percent failures versus the temperature stress level for Group II - Temperature Stress I, and Group III - Temperature Stress II. The graphs of Figures 3 and 5 plot the time step for Group II (160 hours) and Group III (16 hours) versus the temperatures T_1 and T_2 calculated from Figures 2 and 4. Tables 8 and 9 summarize the failures encountered for all three stress groups. The failures are separated into two categories: catastrophic failures in Table 8 and parametric failures in Table 9. The data from Table 8 were used as a source for the graphs in Figures 2 and 4. Figures 2 and 4 were used as a source for the graphs in 3 and 5, respectively. Junction temperature is plotted on an inverse hyperbolic

scale.

5.0 CONCLUSIONS

In each of the three tests, the Semtech sample lot performed better than the Micro Semiconductor sample lot. The three Semtech lots produced a total of two catastrophic failures whereas each Micro Semiconductor lot had to be stopped because of a 50% or higher failure rate. Since both Semtech failures were due to excessive reverse leakage current, only one diode underwent failure analysis. The analysis showed that the reverse leakage current failure was due to surface contamination which was driven out of the glass under the high temperature and bias of the step stress test.

The failure mode for the Micro Semiconductor lots was visual because of a detaching lead. During the Group I testing, one diode cracked in half. Failure analysis on this group showed the glass of the analyzed diodes cracked due to the high junction temperatures reached in the stress testing. The leads fell off where the lead bonding material exceeded its melting temperature. The Group II diodes that were analyzed met all the specified limits for reverse leakage current. Those which dould be tested for V_F met the limit. It was noticed that the diodes which were missing paint were quite sensitive to light, which caused a large increase in the leakage measurement.

Complete graphs showing cumulative failures for Group II and III for the Semtech sample lot could not be drawn because of an insufficient number of Group II failure points and an absence of Group

III failure points (Figures 2 and 3). Because of the visual failures in both Groups II and III, a complete graph for the Micro Semiconductor sample lot could not be drawn (Figures 4 and 5).
A broken circle around a marked point on the graph indicates a freak failure not calculated as part of the regression line. A solid circle around a marked point indicates an isolated main failure point. The regression line was calculated using the least squares method.

The activation energy was calculated from the formula:

$$E = \left[\ell n \left(\frac{t_1}{t_2} \right) \right] \left[\frac{8.63 \times 10^{-5} \text{ eV/}^{\circ}\text{K}}{\left(\frac{1}{T_1 + 273} \right) - \left(\frac{1}{T_2 + 273} \right)} \right] \text{eV}$$

Where: t_1 = step of Group II - Temp Stress I = 160 hrs.

t_2 = step of Group III - Temp Stress II = 16 hrs.

T_1 = temperature in $^{\circ}$C of 16% failure for Group II.

T_2 = temperature in $^{\circ}$C of 16% failure for Group III.

NOTE:

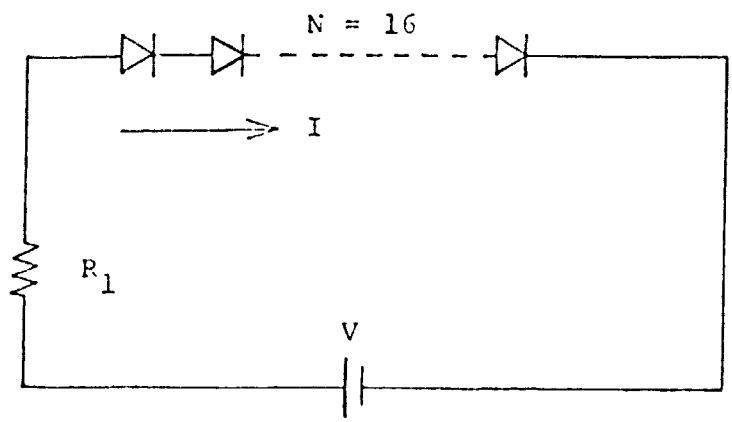
* Conditions for failure:

A) Open or short

B) Leakage exceeds the maximum limit by 100 times

C) Other parameters exceed MIL limits by 50% or more.

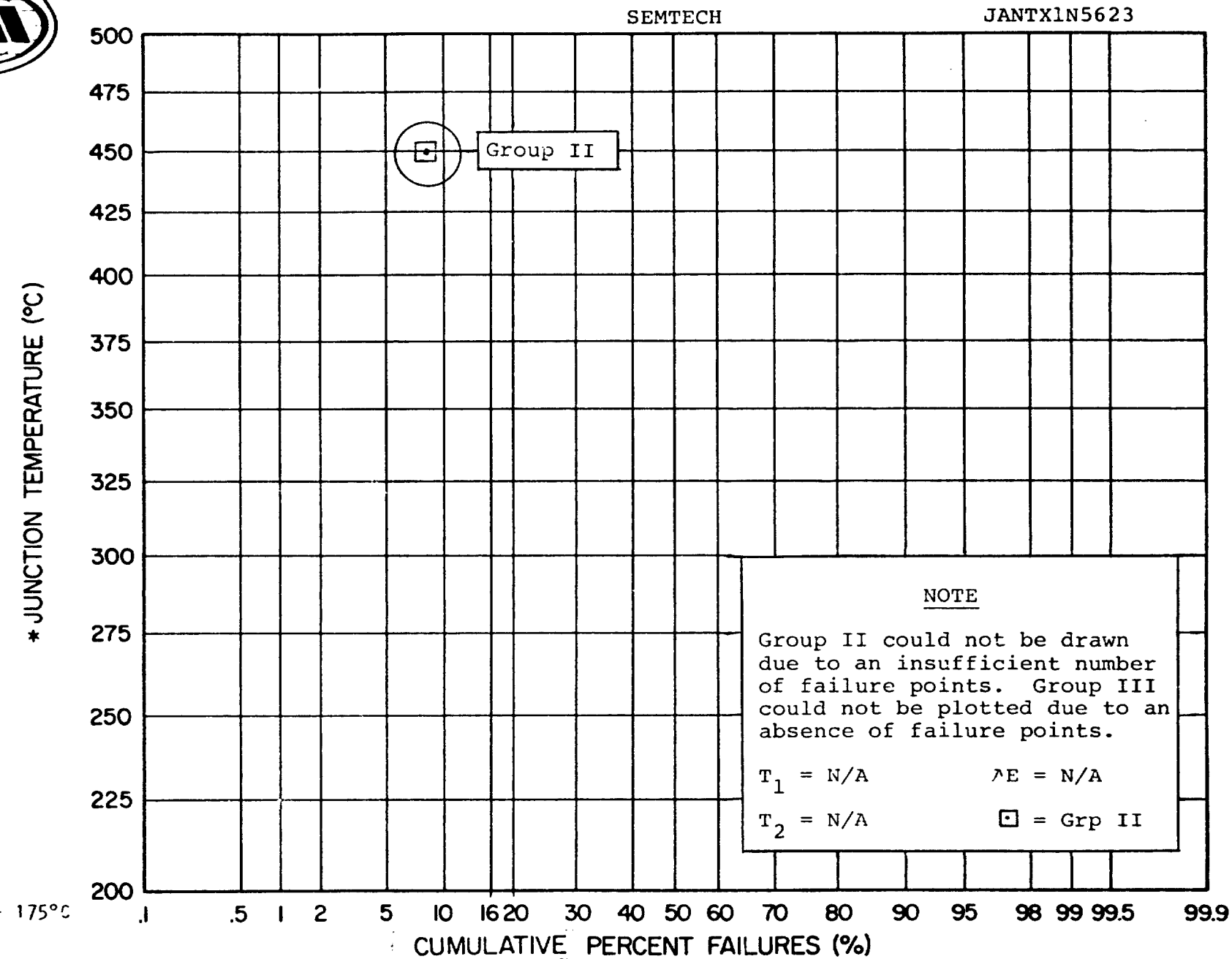
SWITCHING DIODES



$R_1 = 1V/_I \pm 1\%$

$P_d = IE$

FIGURE 1
Power/Temperature Stress Circuit
for JANTX1N5623



*NOTE

$T_J \simeq T_A + 175°C$

FIGURE 2
Cumulative Percent Failures Versus Junction Temperature, Semtech

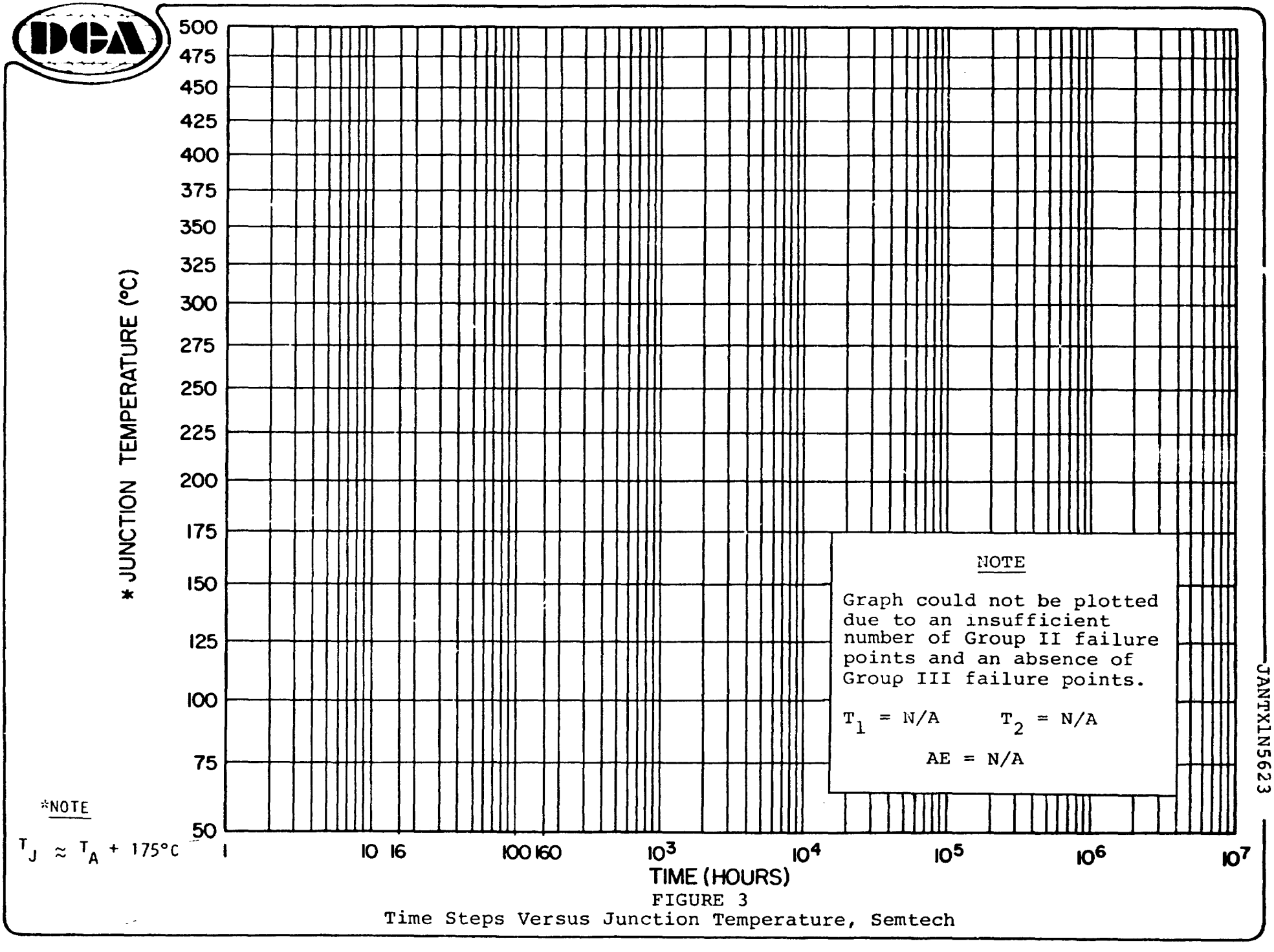
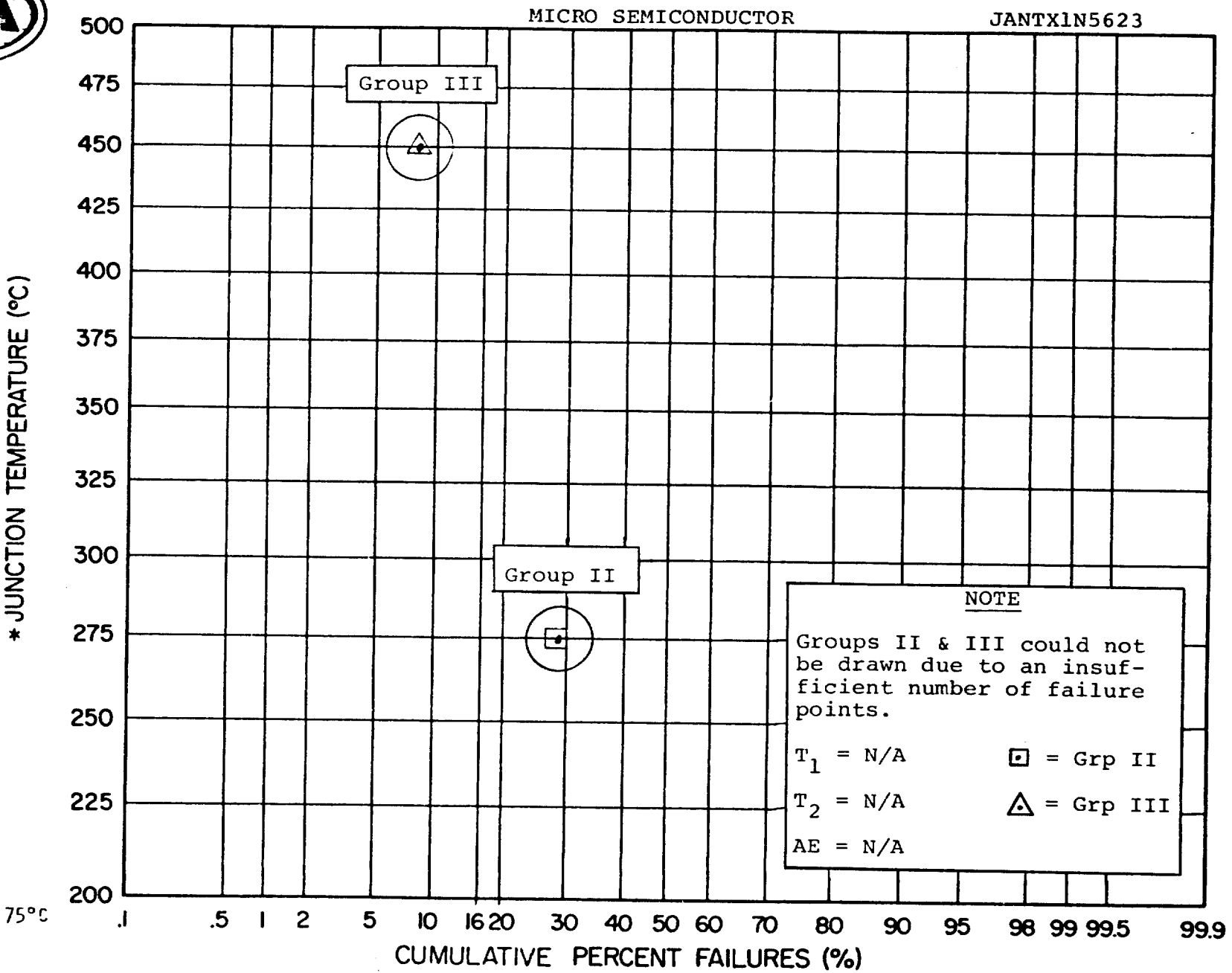


FIGURE 3
Time Steps Versus Junction Temperature, Semtech

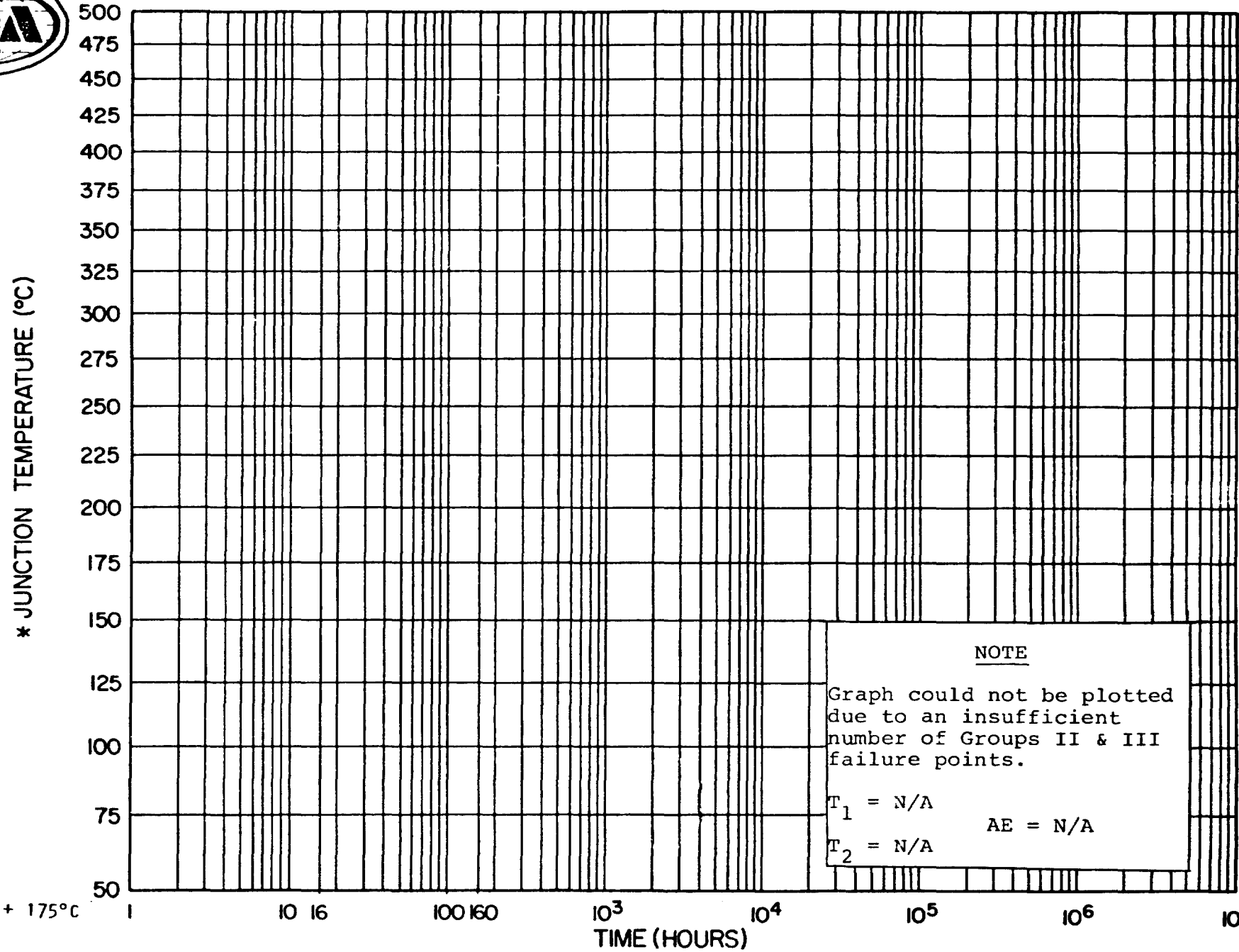


*NOTE

$T_J \approx T_A + 175°C$

FIGURE 4

Cumulative Percent Failures Versus Junction Temperature, Micro Semiconductor



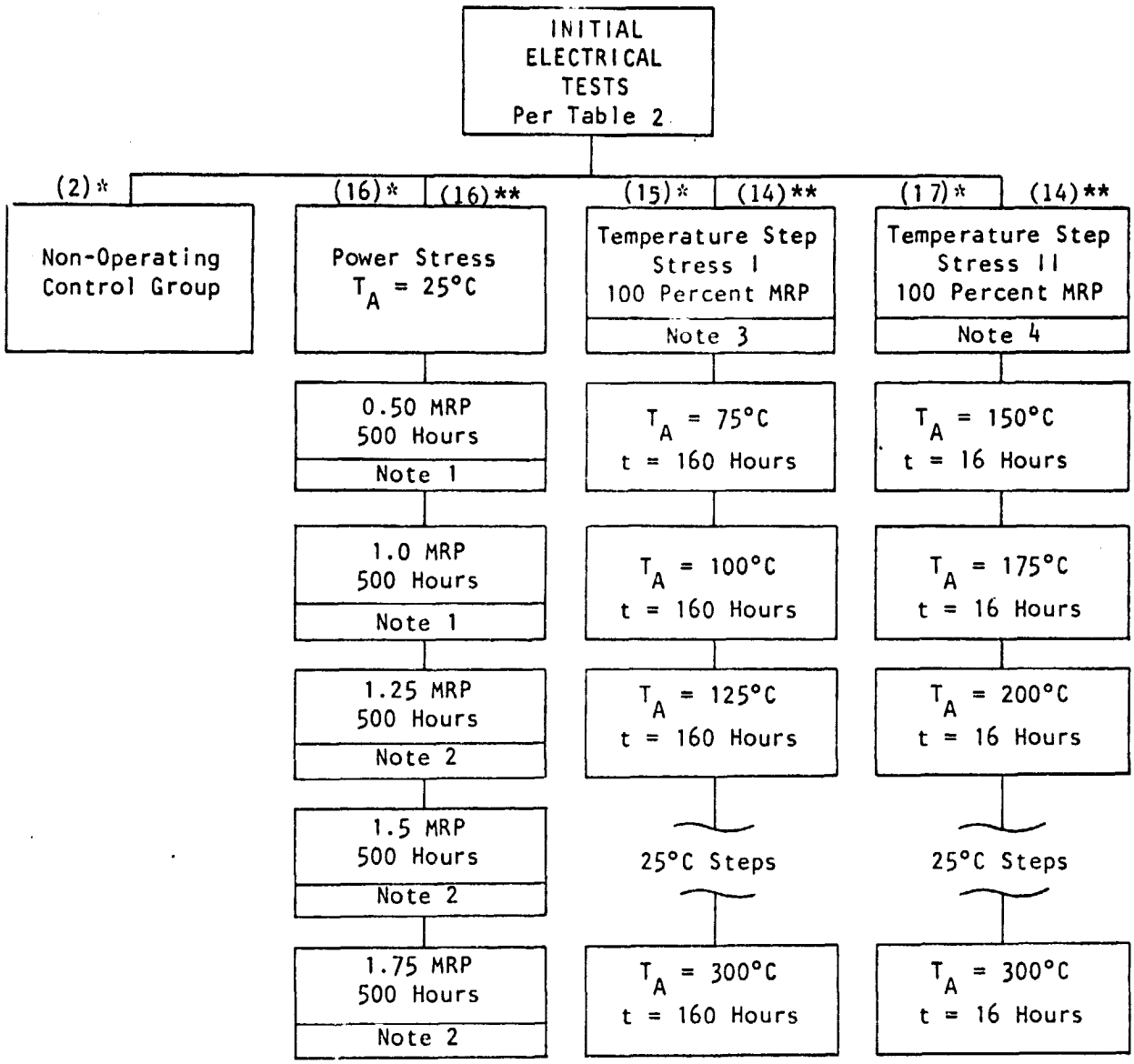
*NOTE

$T_J \approx T_A + 175°C$

FIGURE 5

Time Steps Versus Junction Temperature, Micro Semiconductor

TABLE 1
TEST FLOW DIAGRAM



*Quantity per manufacturer (SEMTECH)
** Quantity per manufacturer (MICRO SEMICONDUCTOR)

NOTES:

1) Electrical measurements per Table 2 were made at 50, 150, 250 and 500 hours.
2) Electrical measurements per Table 2 were made at 10, 25, 50, 150, 250 and 500 hours.
3) Electrical measurements per Table 2 were made at the end of each 160 hours.
4) Electrical measurements per Table 2 were made at the end of each 16 hours.

TABLE 2
PARAMETERS AND TEST CONDITIONS

PARAMETER	CONDITIONS	SPEC. LIMIT		CAT. LIMIT		UNITS
		MIN	MAX	MIN	MAX	
I_R	@ V_R = 1000V		.5		50	µA
V_F	@ I_F = 3.0A (Pulsed)	.8	1.6	.4	2.4	V

NOTES:
1/ In addition, any open or short shall be considered catastrophic.

TABLE 3
POWER STRESS BURN-IN CONDITIONS

V_F = 1.0V	
I_F =	Percent P_D
0.6A	50
1.2A	100
1.5A	125
1.8A	150
2.1A	175

NOTE
FOR TABLES
4 THROUGH 7

The minimum/maximum initial and final data generally have an absolute accuracy of ±1% of the reading and ± one digit except for readings greater than 9.99mA which have an absolute accuracy of ±2% of the reading and ± one digit. The data also have a resolution for four digits. The standard deviations, means, delta means, and average means are, therefore, valid indicators of trends over time and temperature, excepting the minor statistical computer error of supplying a constant number of significant digits.

TABLE 4
GROUP I – POWER STRESS DATA SUMMARY

PARAMETER	I_R = .5μA (MAX)		V_F = .8V(MIN) 1.6V(MAX)					
CONDITIONS AND LIMIT	V_R = 1000V		@ I_F = 3.0A (Pulsed)					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	14.00nA	252.0nA	1.120V	1.350V				
MAX VALUE	148.00nA	467.0nA	1.370V	1.590V				
MEAN	58.24nA	346.6nA	1.218V	1.506V				
STD DEV	38.83nA	66.8nA	0.062V	0.063V				
INTERIM DATA								
POWER 50 TO 125% Δ MEAN VALUE								
50% POWER								
50 HRS	-12.38nA	-65.3nA	0.004V	-0.002V				
150 HRS	-8.16nA	-45.6nA	0.003V	-0.003V				
250 HRS	-2.42nA	-1.4nA	0.001V	0.000V				
500 HRS	1.53nA	4.7nA	0.003V	0.002V				
100% POWER								
550 HRS	-2.59nA	11.3nA	0.003V	0.014V				
650 HRS	1.61nA	47.9nA	0.004V	0.016V				
750 HRS	-3.68nA	161.8nA	0.009V	0.019V				
1000 HRS	0.30nA	-24.0nA	0.008V	0.007V				
125% POWER								
1010 HRS	0.78nA	JOB STOPPED	-0.001V	JOB STOPPED				
1025 HRS	-11.36nA	↓ ↓	0.012V	↓ ↓				
1050 HRS	0.09nA		0.011V					
1150 HRS	2.38nA		-0.009V					
1250 HRS	11.88nA		0.011V					
1500 HRS	24.91nA		0.004V					

(continued on second sheet)

TABLE 4 (Cont'd)
GROUP I — POWER STRESS DATA SUMMARY

(continued from first sheet)

PARAMETER	I_R = .5μA(MAX)		V_F = .8V(MIN) 1.6V(MAX)					
CONDITIONS AND LIMITS	V_R = 1000V		@ I_F = 3.0A (Pulsed)					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	14.00nA	252.0nA	1.120V	1.350V				
MAX VALUE	148.00nA	467.0nA	1.370V	1.590V				
MEAN	58.24nA	346.6nA	1.218V	1.506V				
STD DEV	38.83nA	66.8nA	0.062V	0.063V				
INTERIM DATA								
POWER 150 TO 175% Δ MEAN VALUE								
150% POWER								
1510 HRS	74.46nA		0.015V					
1525 HRS	48.96nA		0.010V					
1550 HRS	64.36nA		0.009V					
1650 HRS	91.16nA		-0.005V					
1750 HRS	47.46nA		0.016V					
2000 HRS	106.76nA		0.015V					
175% POWER								
2010 HRS	67.36nA		0.014V					
2025 HRS	65.96nA		0.015V					
2050 HRS	74.66nA		0.014V					
2150 HRS	188.56nA		0.013V					
2250 HRS	116.26nA		0.012V					
2500 HRS	137.66nA		0.003V					
FINAL DATA								
MIN VALUE	41.40nA	248.0nA	1.120V	1.360V				
MAX VALUE	680.00nA	390.0nA	1.400V	1.590V				
MEAN	195.90nA	322.6nA	1.221V	1.513V				
STD DEV	172.90nA	55.1nA	0.071V	0.080V				

*NOTE: Catastrophic reject(s) removed from data after this point.

TABLE 5

GROUP II TEMP STRESS I DATA SUMMARY

PARAMETERS	I_R = .5μA(MAX)		V_F = .8V(MIN) 1.6(MAX)					
CONDITIONS AND LIMITS	@ V_R = 1000V		@ I_F = 3.0A (Pulsed)					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	14.40nA	196.0nA	1.140V	1.310V				
MAX VALUE	254.00nA	2.5μA	1.370V	1.600V				
MEAN	59.94nA	544.0nA	1.220V	1.484V				
STD DEV	61.42nA	546.5nA	0.061V	0.065V				
INTERIM DATA (INITIAL TO FINAL)								
Δ MEAN VALUE								
TOTAL HRS / TEMP (T_A)								
160 / 75°C	3.09nA	-95.6nA	0.006V	0.005V				
320 / 100°C	7.02nA	519.6μA	0.009V	0.005V				
480 / 125°C	15.00nA	1664.5μA	0.012V	1.434V				
640 / 150°C	23.25nA	JOB STOPPED	0.015V	JOB STOPPED				
800 / 175°C	75.46nA	↓	0.014V	↓				
960 / 200°C	703.76nA	↓	0.013V	↓				
1120 / 225°C	1.18μA	↓	0.013V	↓				
1280 / 250°C	170.16nA	↓	0.006V	↓				
1440 / 275°C	154.04μA	↓	0.000V	↓				
1600 / 300°C	JOB STOPPED	↓	JOB STOPPED	↓				
FINAL DATA								
FINAL TEMP (T_A)	275°C	125°C	275°C	125°C				
MIN VALUE	34.50nA	0.184μA	1.160V	1.350V				
MAX VALUE	1.38mA	9.990mA	1.370V	9.990V				
MEAN	154.10μA	1.665mA	1.220V	2.918V				
STD DEV	433.40μA	3.723mA	0.068V	3.164V				

*NOTE: Catastrophic reject(s) removed from data after this point.

TABLE 6

GROUP III TEMP STRESS II DATA SUMMARY

PARAMETERS	I_R = .5 A(MAX)		V_F = .8V(MIN) 1.6(MAX)					
CONDITIONS AND LIMITS	@ V_R = 1000V		@ I_F = 3.0A (Pulsed)					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	19.20nA	0.340µA	1.120V	1.260V				
MAX VALUE	267.00nA	24.600µA	1.340V	1.520V				
MEAN	80.32nA	2.135µA	1.236V	1.363V				
STD DEV	79.90nA	6.231µA	0.059V	0.084V				
INTERIM DATA (INITIAL TO FINAL)								
Δ MEAN VALUE								
TOTAL HRS / TEMP (T_A)								
16 / 150°C	13.87nA	-1.193µA	0.003V	0.013V				
32 / 175°C	20.88nA	-1.242µA	0.005V	0.032V				
48 / 200°C	516.38nA	-1.229µA	0.005V	0.009V				
64 / 225°C	1.71µA	-1.490µA	0.009V	0.006V				
80 / 250°C	228.78nA	-1.727µA	0.017V	-0.002V				
96 / 275°C	19.15nA	73.925µA	0.005V	-0.009V				
112 / 300°C	20.58nA	JOB STOPPED	0.009V	JOB STOPPED				
FINAL DATA								
FINAL TEMP (T_A)	300°C	275°C	300°C	275°C				
MIN VALUE	30.0nA	300.00nA	1.130V	1.250V				
MAX VALUE	374.0nA	908.00µA	1.360V	1.540V				
MEAN	100.9nA	76.06µA	1.245V	1.354V				
STD DEV	88.2nA	250.80µA	0.064V	0.083V				

* NOTE: Catastrophic reject(s) removed from data after this point.

TABLE 7
FINAL DATA SUMMARY

PARAMETER	SPECIFICATIONS LIMIT		UNITS	MEAN INT. DATA	AVERAGE Δ IN MEAN VALUE					
					POWER STRESS		TEMPERATURE STRESS I		TEMPERATURE STRESS II	
	MIN	MAX			SEM	MSC	SEM	MSC	SEM	MSC
I_R		0.5	μA		+.04179	+.01118	+17.358	+728.00	+.36138	+11.174
V_F	0.8	1.6	V		+.00746	+.00663	+.00978	+.48133	+.00757	+.00817

*NOTE: Catastrophic reject(s) removed from data after this point.

TABLE 8 STEP STRESS CATASTROPHIC FAILURE SUMMARY JAN TX1N5623

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	0	–
100% 50 hr.	0	–	0	–
100 hr.	0	–	1	A
100 hr.	0	–	1 \ 1	A \ B
250 hr.	0	–	5	B
125% 10 hr.	0	–	JOB STOPPED	
15 hr.	0	–	↓	↓
25 hr.	0	–		
100 hr.	0	–		
100 hr.	0	–		
250 hr.	0	–		
150% 10 hr.	0	–		
15 hr.	0	–		
25 hr.	0	–		
100 hr.	0	–		
100 hr.	0	–		
250 hr.	0	–		
175% 10 hr.	0	–		
15 hr.	0	–		
25 hr.	1	A		
100 hr.	0	–		
100 hr.	0	–		
250 hr.	0	–	↓	↓

GROUP II 160 HR. TEMP. STEPS

TEST STEP (T_A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75° C	0	–	0	–
100° C	0	–	4 \ 2	A \ B
125°C	0	–	1 \ 1	B \ C
150°C	0	–	JOB STOPPED	
175°C	0	–	↓	↓
200°C	0	–		
225°C	0	–		
250°C	0	–		
275°C	1	A		
300°C	JOB STOPPED			

GROUP III 16 HR. TEMP. STEPS

TEST STEP (T_A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150°C	0	–	0	–
175°C	0	–	0	–
200°C	0	–	0	–
225°C	0	–	0	–
250°C	0	–	2	B
275°C	0	–	1 \ 5	A \ B
300°C	0	–	JOB STOPPED	

MFR "A" - SEMTECH

MFR "B" - MICRO SEMICONDUCTOR

NOTES: A - I_R > 50μA

B - Visual (other than handling)*

C - Visual (other than handling)**

* Lead detaching from the stress.

** Device breaking in half from the stress.

TABLE 9 STEP STRESS PARAMETRIC FAILURE SUMMARY JAN TX1N5623

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	1	A
100% 50 hr.	0	–	1 1	A B
100 hr.	0	–	1	A
100 hr.	0	–	1	A
250 hr.	0	–	0	–
125% 10 hr.	0	–	JOB STOPPED	
15 hr.	0	–		
25 hr.	0	–		
100 hr.	0	–		
100 hr.	0	–		
250 hr.	0	–		
150% 10 hr.	1	A		
15 hr.	0	–		
25 hr.	0	–		
100 hr.	0	–		
100 hr.	0	–		
250 hr.	0	–		
175% 10 hr.	0	–		
15 hr.	0	–		
25 hr.	0	–		
100 hr.	1	A		
100 hr.	0	–		
250 hr.	0	–		

GROUP II 160 HR. TEMP. STEPS

TEST STEP (T_A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75° C	0	–	4	A
100° C	0	–	0	–
125° C	0	–	0	–
150° C	0	–	JOB STOPPED	
175° C	1	A		
200° C	2	A		
225° C	2	A		
250° C	2 4	A C		
275° C	1 2	A D		
300° C	JOB STOPPED			

GROUP III 16 HR. TEMP. STEPS

TEST STEP (T_A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150°C	0	–	4	A
175°C	0	–	1	A
200°C	1	A	1	A
225°C	0	–	1	A
250°C	0	–	0	–
275°C	0	–	0	–
300°C	0	–	JOB STOPPED	

MFR "A" - SEMTECH

MFR "B" - MICRO SEMICONDUCTOR

NOTES:

A - I_R maximum limit failure.

B - V_F maximum limit failure.

C - S/N 7805. 7806, 7826 and 7830 removed from Group II Testing as a MIL-S-19500 limit failure.

D - S/N 7828 and 7832 removed from Group II Testing as a MIL-S-19500 limit failure.

APPENDIX A

FAILURE ANALYSIS

POWER STRESS

FAILURE ANALYSIS

Date 5 January 1979

J/N 2CN242-19A **P/N** 1N5623 **MFR** SEMTECH

FAILURE VERIFICATION:

S/N	PIV -volts-	End Point: 50μA Max. I_R @ 1000 V.dc	End Point: 0.4-2.4V V_F @ 3.0A dc	INITIAL REJ. AT TEST SEQUENCE NO.:	INITIAL REJ. FOR:
7818	>1100 (Uns)	100μA	1.8V	53 (175% MRP 1600 Hrs.)	I_R

VISUAL INSPECTION

The external paint is missing. There are no other visual defects on this sample (see Figure A-1).

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)
**h_{FE} trace very leaky.

D=drift H=hysteresis Inv=inversion R=resistive S=soft Uns=unstable

FAILURE ANALYSIS

Date 5 January 1979

J/N 2CN242-19A **P/N** 1N5623 **MFR** MICRO SEMICONDUCTOR

FAILURE VERIFICATION:

S/N	PIV -volts-	I_R @ 1000 V.dc (End Point: 50μA Max.)	V_F @ 3.0A dc. (End Points: 0.4-2.4V)	INITIAL REJ. AT TEST SEQUENCE NO.:	INITIAL REJ. FOR:
7846	Cannot be tested	Cannot be tested		17 (100% MRP 1000 Hrs.)	Broken glass
7872	620		Cannot test	15 (100% MRP 750 Hrs.)	Lead off
7875	>1100	450μA	Cannot test	17 (100% MRP 1000 Hrs.)	Lead off

VISUAL INSPECTION

S/N 7846 has a broken glass case and silicon die (see Figure A-2).

S/N 7872 and 7875 have cracked glass and a missing lead (see Figure A-3).

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)
**h_{FE} trace very leaky.

D=drift H=hysteresis Inv=inversion R=resistive S=soft Uns=unstable

CONCLUSIONS

Semtech sample number 7818 has failed for reverse leakage current because of surface contamination which was driven out of the glass under the high temperature and bias of the step stress test.

The glass of all the Micro Semiconductor diodes cracked due to the high junction temperatures reached in this stress testing. The leads fell off when the lead bonding material exceeded its melting temperature.

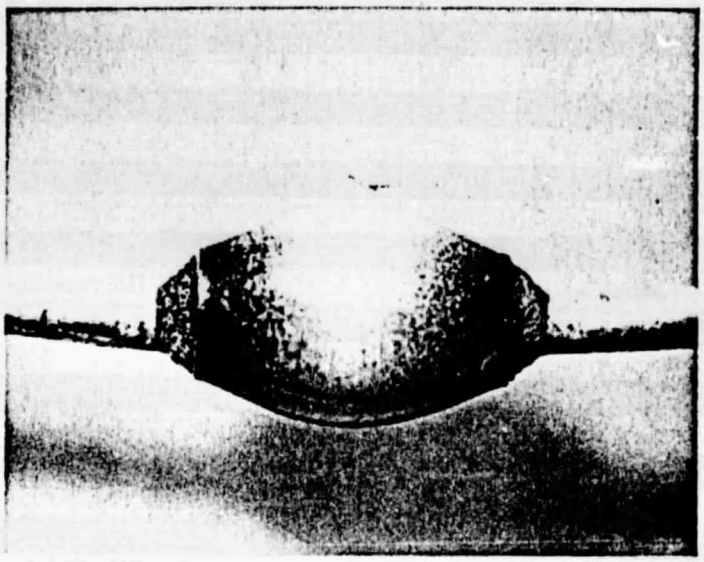


FIGURE A-1
S/N 7818, Semtech device, 10X.

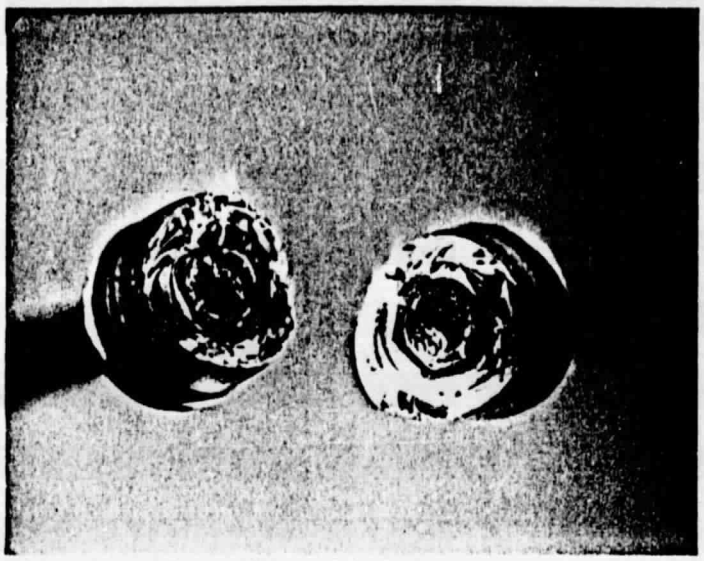


FIGURE A-2
S/N 7846, Micro Semiconductor, 10X.
Sample showing broken glass and die.

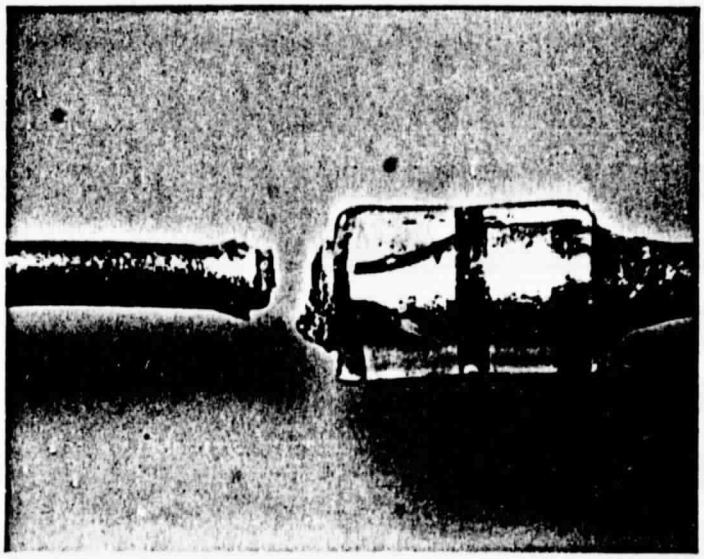


FIGURE A-3
S/N 7872, Micro Semiconductor, 10X.
Typical cracked glass and detached external lead.

APPENDIX B

FAILURE ANALYSIS

TEMPERATURE STRESS

FAILURE ANALYSIS

Date 14 April 1978

J/N 2CN242-19C **P/N** 1N5623 **MFR** MICRO SEMICONDUCTOR

FAILURE VERIFICATION:

S/N	PIV -volts-	I_R @ 1000 V.dc lim = 0.5μA	V_F @ 3A dc lim = 1.6μ	INITIAL REJ. AT TEST SEQUENCE NO.:	INITIAL REJ. FOR:
7631	1080	300 nA	1.36	13	I_R; lead off
7628	1100	300 nA	1.42	13	I_R; lead off
7629	500	300 nA	Cannot test	01 and 05	I_R; lead off

VISUAL INSPECTION

The MSC diodes fell apart where the external leads were connected to the heat sink. These losses occurred at test sequence 11 (250°C) and 13 (275°C). Paint is missing from all parts. S/N 7629 also has cracked glass (see Figure B-1). All external leads are oxidized but still conductive.

CONCLUSIONS

At the time of this analysis, the three samples met the specified limits for reverse leakage current and the two which could be tested for V_F met the limit. It was noticed that the diodes with their missing paint were quite sensitive to light, which caused a large increase in the leakage measurement.

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)
**h_{FE} trace very leaky.

D=drift H=hysteresis Inv=inversion R=resistive S=soft Uns=unstable

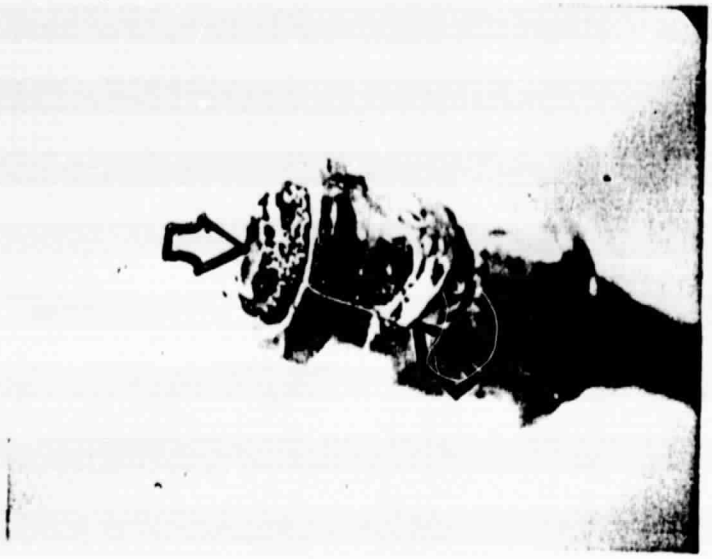


FIGURE B-1
S/N 7629, Micro Semiconductor, 25X.
Arrows indicate missing lead
location and cracked glass.